

**Species of *Orasema* parasitic on the *Solenopsis saevissima*-complex
in South America (Hymenoptera: Eucharitidae, Formicidae)**

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Abstract.— The South American species of the *Orasema xanthopus*-group are revised. The five species included are *O. pireta* n. sp., *O. salebrosa* n. sp., *O. simplex* n. sp., *O. worcesteri* (Girault) (*O. doellojuradoi* Gemignani as new synonym), and *O. xanthopus* (Cameron) (*Eucharomorpha paraguayensis* Girault and *O. crassa* DeSantis as new synonyms). Immature stages are described for three of the species. Ant hosts include *Pheidole radoszkowskii* Mayr, *Solenopsis invicta* Buren and *Solenopsis richteri* Forel (all Myrmicinae). The life history of *O. xanthopus* is discussed.

Several reports have mentioned a species of *Orasema* (Hymenoptera: Eucharitidae) that is a parasite of fire ants in South America (Silveira-Guido et al. 1964; Williams and Whitcomb 1973; Williams 1980; Wojcik 1988, 1989; Wojcik et al. 1987). These parasites are dominant among the insect parasites of fire ants in Brazil and, in 1585 collections of colonies from Brazil, represented about 80% of all myrmecophilous arthropods recovered (Wojcik et al. 1987). Parasites of ants in the *Solenopsis saevissima*-complex, revised by Trager 1991, all belong to a single species group of *Orasema* that occurs over the same range as the host complex in South America.

Almost all species of *Orasema* are parasites of Myrmicinae (Formicidae) and are known to parasitize ants in the genera *Pheidole*, *Solenopsis*, *Tetramorium* and *Wasmannia* (Heraty in press-b). Females deposit a single egg into a chamber formed in leaf tissue using a specialized ovipositor (Johnson et al. 1986, Heraty in press-a,b). The first-instar larvae reach the ant nest by some means of phoretic behaviour, either through attachment to an ant or to an intermediate insect host, and then parasitize the host larva (Johnson et al. 1986, Heraty in press-a,b). Development is completed on the pupal stage of the host.

Collections of colonies of *Solenopsis invicta* Buren from Bolivia and Brazil, and *Solenopsis richteri* Forel from Argentina, have permitted for study of the immature stages of three species, and

these are described here. The life histories and structures of the immature stages do not differ greatly from those first described by Wheeler (1907) for other species of *Orasema*; however, differences in structure at the species level do exist. Within this species-group of *Orasema*, the oviposition habits, plant host, and behavior of planidia outside of the host colony remain largely unknown. This paper provides diagnoses and correct nomenclature, and summarizes the distribution and biology for species of *Orasema* that are known to be parasites of fire ants of South America.

The terms used in the descriptions follow Heraty (1989, in press-a). Museum acronyms are described in the acknowledgements.

***Orasema xanthopus*-group**

The five species included in the *xanthopus*-group have the following combination of character states: funicle 8-segmented, scape yellowish brown, face and mesoscutum reticulate, and axillular sulcus at least partially discernible. The hind femora is dark brown to black medially in all included species, but sometimes not in all specimens of each species; however, this combination of a darkened femora with the other character states listed above is unique among *Orasema*. This group of species may be paraphyletic with respect to a monophyletic group that includes *Orasema aenea* (Gahan), which is distinguished by: mesosomal dorsum coarsely

rugose, axillular sulcus absent, and femora always completely yellowish brown. **Group Description** [diagnostic characters in bold type]. Colour of head, mesosoma, coxae and petiole usually dark (rarely bright) olive- or bluish-green, sometimes with red or purple iridescent patches; gaster dark brown with bluish green reflections; **scape yellowish brown**, with following segments, including pedicel and anellus, brown; **all femora usually at least slightly darker medially** with apicies yellowish brown, rarely completely yellowish brown, tibiae yellowish brown. Wings hyaline, veins light brown.

Head 1.2-1.5X as broad as high; occiput broadly emarginate in dorsal view. **Face, including scrobal depression, finely reticulate**; scrobes shallow and narrowed medially (Figs. 1-5), median ocellus partially included; toruli separated by distance equal to their diameter; occiput aciculate, dorsal margin without carina but angle sharp at vertex. Eyes bare. Clypeus transverse and distinctly shorter than supraclypeal area, apical margin of clypeus nearly straight, lateral margin deeply impressed at tentorial pit; frontogenal sulcus meeting torulus at outer margin. Malar depression weakly impressed adjacent to oral fossa. **Labrum with 4 long digits**. Mandibles 3/2 dentate; maxillary palpus with 3 segments, labial palpus with 2 or 3 segments. Antenna with 12 segments; anellus distinct; **funicle in both sexes with 8 segments**; clava subconical and

rounded apically.

Mesosoma with **midlobe of mesoscutum reticulate**, and side lobe with similar but weaker sculpture dorsally. Notaulus and scutoscutellar sulcus deeply impressed and crenulate. Axillular sulcus at least weakly indicated. Disc of propodeum evenly sculptured. Transepimeral sulcus distinct; mesepisternum evenly reticulate except for anterior and ventral regions. Prepectus triangular. Proepisternum weakly sculptured. **Hind coxa reticulate dorsally**. Fore wing 2.2-2.6X as long as broad and broadly rounded apically; **basal area bare except for setae along impression of cubital vein**, costal cell pilose, **speculum present** and closed basally, disc pilose and hyaline with prominent marginal fringe; stigmal vein angled slightly towards apex of wing; postmarginal vein 2-4X as long as stigmal vein.

Petiole of female 0.8-1.0X as long as hind coxa, that of male 1.0-1.4X as long as hind coxa; **petiole smooth, weakly rugose (wrinkled) or finely reticulate**, cylindrical with basal flange usually weak. First gastral sternite (Ms^2) with transverse crenulate sulcus. Ovipositor expanded subapically; first valvula with lateral line of 4 to 10 prominent teeth distal to subapical ridge; second valvula broad with 7-9 lateral teeth, and with or without weak transverse ridges. Genitalia typical for genus; basiparamere robust and broad, paramere short and well sclerotized, aedeagus subtruncate.

KEY TO SPECIES OF THE *ORASEMA XANTHOPUS*-GROUP

1. Petiole finely and strongly reticulate *worcesteri* Girault
— Petiole smooth, weakly rugose, or carinate (if present, rugae smooth and hardly raised above surface) 2
2. Petiole of female 2.6-3.1X as long as broad, completely smooth with 1 or 2 longitudinal carinae basally; mesepimeron and callus smooth; callus with prominent nib (male unknown) ... *pireta* Heraty, n. sp.
— Petiole of female 1.3-2.0X as long as broad, petiole of both sexes weakly rugose or carinate; mesepimeron and callus usually with prominent sculpture, callus without nib 3
3. Scutellum scabrous dorsally; callus rugulose and with 10-12 prominent hairs
..... *salebrosa* Heraty, n. sp.
— Scutellum finely reticulate dorsally; callus coriaceous or mostly smooth and with 2-4 minute hairs or bare 4
4. Axillular sulcus indistinct, at most vaguely indicated by change in sculpture; dorsal margin of scutellum flat in profile; femora of both sexes mostly dark brown to black ... *simplex* Heraty, n. sp.
— Axillular sulcus distinct and foveate, at least anteriorly; dorsal margin of scutellum rounded in profile; femora of both sexes weakly to strongly darkened medially, that of male weakly darkened or completely yellowish brown *xanthopus* (Cameron)

Orasema pireta Heraty, new species

(Fig. 1)

Holotype, female "PARAGUAY: Pirareta, 26.xii.1971, L.E. Peña." Deposited in CNC.

Paratypes: PARAGUAY: same data (2 females, CNC; 1 female, USNM); same locality and collector, 23-25.xii.1971 (1 female, CNC).

Diagnosis.—Within the *xanthopus*-group, recognized by: petiole narrow and elongate, 2.6-3.1X as long as broad, and mostly smooth and shining with at most with few weak longitudinal carinae in basal third; mesepimeron, callus and metepimeron smooth; callus with 2-3 minute setae and with prominent calar nib; femora of female completely yellowish brown or weakly fuscate medially; axillular sulcus strongly impressed.

Description of female.—Length, 3.0-3.9 mm. Colour of head and body dark brown with greenish-blue reflections, strongest on head and mesosomal dorsum [may be partially bleached in these specimens].

Head 1.3-1.4X as broad as high (Fig. 1). Facial sculpture reticulate with interstices hardly raised above surface, intertorular area smooth. Eyes separated by 1.8X their height. Malar space 0.8-0.9X height of eye. Clypeus and supraclypeal area swollen medially, clypeus smooth with few small setae. Flagellum 1.6-1.7X height of head; FL2 1.1-1.4X as long as broad.

Mesosoma with entire dorsum finely reticulate, side lobe of mesoscutum alutaceous. Disc of scutellum slightly longer than broad, flat dorsally (in lateral view), and without median depression; frenum finely reticulate; frenal line broadly and deeply impressed dorsally, strongly angled to scutellar disc (in lateral view), and reticulate dorsally and glabrous laterally; axillula vertical and smooth or with weak rugosity, axillular sulcus strongly impressed and reticulate. Propodeal disc weakly reticulate or alutaceous laterally and with broad median areolate depression; callus swollen and smooth, with 2-3 minute hairs dorsally or bare, and with prominent callar nib. Mesepimeron smooth. Fore wing 2.3-2.5X as long as broad.

Petiole 1.3-1.5X as long as broad, 0.6-0.8X as long as hind coxa; petiole entirely smooth, sometimes with few weak longitudinal carinae in basal

third, the basal flange weak. First valvula of ovipositor with lateral line of 4 to 7 prominent teeth; second valvula with 7 lateral teeth connected by weak transverse ridges.

Male.—Unknown.

Host and immature stages.—Unknown.

Etymology.—Adapted from the name of the type locality.

Orasema salebrosa Heraty, new species

(Figs. 2, 19)

Holotype, female "ARGENTINA: Buenos Aires P., San Carlos de Bolivar, RN-226, 8.iv.1987, D.P. Wojcik 87-A-407, ex: floated fire ants." Deposited in CNC.

Paratypes: ARGENTINA: Buenos Aires Prov.: same data as holotype (1 female, CNC); Suipacha, RN-5, km 127, 28.x.1987, D.P. Wojcik, 87-A-590, ex: floated *Solenopsis richteri* (1 female, 1 male, 4 female pupae, CNC; 1 female, USNM); San Carlos de Bolivar, RN-226, 8.iv.1987, D.P. Wojcik, 87-A-407, ex floated fire ants (1 female, CNC).

Diagnosis.—Within the *xanthopus*-group, both sexes recognized by: side lobe of mesoscutum laterally, and scutellum dorsally, scabrous (rugose with interstices strongly raised and sharp); callus rugose with 10-12 hairs dorsally; femora of both sexes dark brown to black medially; axillular sulcus strongly impressed.

Description of female.—Length, 3.0-3.9 mm. Colour of head and body dark bluish green to almost black, sometimes with strong purple reflections laterally.

Head 1.3-1.4X as broad as high (Fig. 2). Face strongly reticulate, intertorular area transversely strigate. Eyes separated by 1.8X their height. Malar space 0.8-0.9X height of eye. Clypeus slightly swollen medially and mostly smooth with moderately dense fine setae. Flagellum 1.6-1.7X height of head; FL2 1.1-1.4X as long as broad.

Mesosoma with mesoscutum and axilla reticulate, scutellum rugose or scabrous, with interstices sharp. Disc of scutellum slightly longer than broad, flat dorsally (in lateral view), and with broad median depression; frenum rugose; frenal line strongly impressed and foveate or crenulate dorsally, glabrous laterally; axillula slightly rounded and rug

ose, axillular sulcus strongly impressed and foveate. Propodeal disc evenly rugose-areolate, without median depression; callus swollen and rugose, with 10-13 hairs dorsally, and without callar nib. Upper mesepimeron swollen and weakly reticulate, lower mesepimeron rugulose. Fore wing (Fig. 5) 2.3-2.5X as long as broad.

Petiole 1.3-1.5X as long as broad, 0.6-0.8X as long as hind coxa; petiole smooth with weak irregular rugae, the basal flange weak. First valvula of ovipositor with lateral line of 8 prominent teeth [second valvula hidden].

Description of male.—Length, 3.1 mm. Eyes separated by 1.8X their height. Malar space 0.8X height of eye. Flagellum slightly longer than in female, 2.2X height of head. Fore wing 2.3X as long as broad. Petiole 2.7X as long as broad, 1.1X as long as hind coxa.

Host.—*Solenopsis richteri* Forel (Myrmicinae).

Immature Stages.—Pupa (Fig. 19). Pupal form is typical for other *Orasema* and recognized by: two enlarged tubercles over petiole, third enlarged tubercle further back over first metasomal tergite; gaster with series of small mid-dorsal tubercles,

decreasing in size, over terga II-V; series of small lateral and subventral tubercles or short ridges on terga I-VI. Average length, 3.67 mm (SD=0.48, n=5).

Etymology.—From Latin *salebrosus* for rough, referring to scutellar sculpture.

***Orasema simplex* Heraty, new species**
(Fig. 3)

Holotype, female "ARGENTINA: Buenos Aires P., RN-9, km 231, jct San Nicolas de los Arroyos" "22.x.1987, D.P. Wojcik 87-A-552-D, ex: floated *Solenopsis richteri*." Deposited in CNC.

Paratypes: ARGENTINA: Buenos Aires: same data (1 male, 1 female pupa, CNC; 1 female, 1 male, USNM); Belen de Escobar, RN-9, km 51, 19.x. 1987, D.P. Wojcik, 87-A-483-H, ex: floated *Solenopsis richteri* (1 female pupa, CNC); La Pampa: 9.ix.1987, N. Puelen (2 females, CNC, NMBA).

Diagnosis.—Within the *xanthopus*-group, both sexes recognized by: frons and mesosomal dorsum very finely reticulate; scutellum flat dorsally,

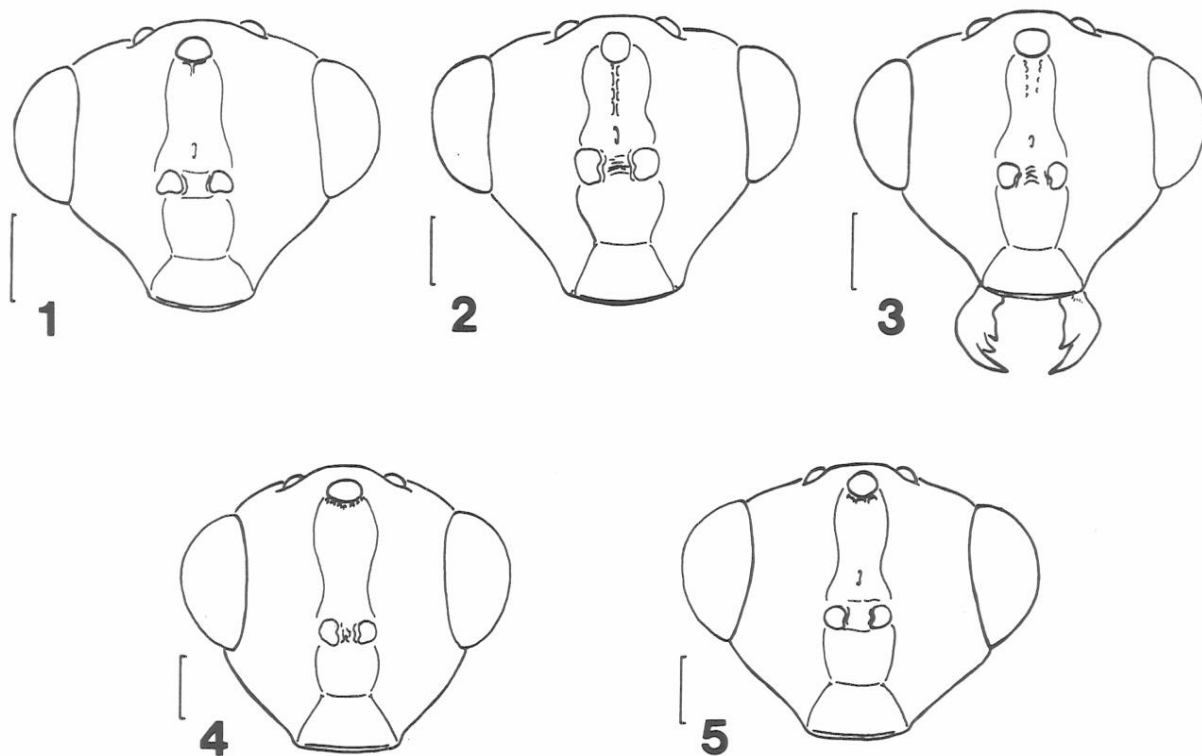


FIG. 15. Thorax of female: 1, *O. nitida*; 2, *O. salebrosa*; 3, *O. simplex*; 4, *O. worcesteri*; 5, *O. xanthopus*.

axillular sulcus weakly impressed, discernable only by change in sculpture; mesepimeron and callus weakly and finely reticulate, and callus bare; petiole smooth with weak and irregular longitudinal rugae; femora of both sexes mostly dark brown or black.

Description of female.—Length, 2.7–3.8 mm. Colour of head and body bright green to dark greenish-blue, sometimes with reddish iridescent patches on mesosoma.

Head 1.3–1.4X as broad as high (Fig. 3). Face strongly reticulate, intertorular area transversely strigate. Eyes separated by 1.7–2.0X their height. Malar space 0.8–0.9X height of eye. Clypeus swollen medially and coriaceous, covered with moderately dense fine setae. Flagellum 1.3–1.4X height of head; FL2 1.3–1.7X as long as broad.

Mesosoma with entire dorsum finely reticulate. Disc of scutellum slightly longer than broad, flat dorsally (in lateral view), and with weak median depression; frenum reticulate; frenal line not impressed dorsally, forming a continuous glabrous band; axillula vertical and longitudinally strigate; axillular sulcus weakly impressed, visible as weak ridge in dorsal view or by change in sculpture. Propodeal disc weakly reticulate or coriaceous, with broad median rugose-areolate depression; callus swollen, weakly reticulate and bare, with weak callar nib. Upper mesepimeron swollen and weakly reticulate, lower mesepimeron mostly smooth. Fore wing 2.1–2.4X as long as broad.

Petiole 1.6–2.0X as long as broad, 0.7–0.8X as long as hind coxa; petiole smooth with weak irregular rugae, the basal flange weak. First valvula of ovipositor with lateral line of 9–10 prominent teeth; second valvula with 11 lateral teeth connected by weak transverse ridges.

Description of male.—Length, 2.7–3.0 mm. Eyes separated by 1.8–1.9X their height. Malar space 0.8X height of eye. Flagellum slightly longer than in female, 1.6X height of head. Fore wing 2.2–2.4X as long as broad. Petiole 2.8–4.1X as long as broad, 1.0–1.4X as long as hind coxa.

Host.—*Solenopsis richteri* Forel (Myrmicinae).

Immature Stages.—Pupa. Form is the same as for *O. salebrosa*, but the lateral tubercles are usually connected by a raised ridge that extends almost

to mid-dorsal series (ridge absent in one specimen and complete in another). Length, 3.4 mm.

***Orasema worcesteri* (Girault)**

(Fig. 4)

Eucharomorpha worcesteri Girault, 1913[157]: 62–63. Type locality: Paraguay, San Bernardino. Holotype, female [examined, ZMHB], by original designation.

Orasema Doello-juradoi Gemignani, 1933: 490–491, figs. 13–14. Type locality, Argentina: Isla Martin Garcia. Holotype, female [examined, NMBA, type no. 31765], by original designation; holotype, paratype and 2 ants mounted on three cards on same pin. The holotype is here assumed to be the top card-mounted specimen.

New Synonymy.

Orasema worcesteri; combination by Bouček, 1988: 519.

Diagnosis.—Within the *xanthopus*-group, female recognized by: femora usually all yellow, sometimes dark brown medially; head subquadrate (Fig. 4); frons and mesosomal dorsum very finely reticulate; scutellum flat dorsally, axillular sulcus weak; mesepimeron and callus weakly and finely reticulate, and callus bare; petiole finely and strongly reticulate with a weak basal flange, petiole shorter than length of hind coxa and 1.4–1.6X as long as broad. This species is similar to *O. simplex*, but differs by having a finely reticulate petiole, which is a unique character state among species with an 8-segmented funicle and a finely reticulate mesosomal dorsum.

Description of female.—Length, 2.8–4.0 mm. Colour of head and body bright green to dark greenish-blue, sometimes with reddish iridescent patches on mesosoma.

Head 1.2–1.3X as broad as high (Fig. 4). Face strongly reticulate, intertorular area rugulose. Eyes separated by 1.4–1.7X their height. Malar space 0.7–0.8X height of eye. Clypeus weakly sculptured or smooth and only slightly rounded medially. Flagellum 1.0–1.4X height of head; FL2 2.0–2.2X as long as broad.

Mesosoma with entire dorsum finely reticulate to granulate. Disc of scutellum 1.2X as long as broad, rounded dorsally (in lateral view), and with-

out median furrow; frenum granulate; frenal line impressed, reticulate dorsally and glabrous laterally; axillula vertical and weakly reticulate or striate, axillular sulcus weakly impressed, marked by difference in sculpture. Propodeal disc finely reticulate laterally, sometimes with broad median alveolate channel; callus reticulate and bare, callar nib absent. Upper mesepimeron weakly reticulate, lower mesepimeron smooth to areolate. Fore wing 2.3-2.5X as long as broad.

Petiole 1.4-1.6X as long as broad, 0.7-1.0X as long as hind coxa; petiole strongly reticulate over entire surface, the basal flange weak. First valvula of ovipositor with lateral line of 4 prominent teeth; second valvula broad with 9 lateral teeth connected dorsally by weak transverse ridges.

Male.—Unknown.

Host and Immature Stages.—The host was originally reported as *Pheidole nitudula* Emery (Gemignani, 1933). E.O. Wilson identified the same specimens as *Pheidole radoszkowskii* Mayr (Myrmicinae). Immature stages unknown.

Material Examined.—ARGENTINA: *Buenos Aires*: San Fernando, xi.1957, Daguerre (1 female, USNM); *Catamarca*: Sumalao, 30.i-5.ii.1958, R. Golbach; *Chaco*: Resistencia, M.V. Viana (1 female, NMBA); *Misiones*: Dept. Concepción, Santa Maria, 1948, M.J. Viana (3 females, NMBA); no city or date (1 female, NMBA); [province?] Amaicha del Valle, 28.xii.1965, H. & M. Townes (1 female, NMBA). PARAGUAY: *Caaguazú*: Estancia Primera, 1.xii.1931 R.F. Hussey (1 female, homotype of *O. worcesteri*, MMZ).

***Orasema xanthopus* (Cameron)**
(Figs. 5, 6-18)

Semora xanthopus Cameron, 1909: 433. Type locality: Argentina, Mendoza. Lectotype, female [examined, BMNH, type number 5.369], here designated. Labels: "Type" "P. Cameron Coll. B.M. 1914-110." "*Semora xanthopus* Cam Type Mendoza" "B.M. TYPE HYM 5.369."

Semorata xanthopus: replacement name by Strand 1942, *Semora* preoccupied by Peckham, 1892.

Semorella xanthopus: unjustified replacement name by Ghesquière, 1946: 368.

Orasema xanthopus: combination by Kerrich, 1963: 36.

Eucharomorpha paraguayensis Girault, 1913: 63. Type locality: Argentina, Mendoza. Holotype, male [examined, ZHMB], monotypic. Labels: "Argentina 4.2., Mendoza 07, Jansen Haarup V" "*Eucharomorpha paraguayensis* Girault male" "S.M.I. Pv. 1045" "ex coll./Girault" "Zool. Mus./Berlin." A slide of an antenna of the holotype, as mentioned in the original description, was not examined. The type locality, Mendoza, was taken from holotype label data; the published locality of San Bernardino (Paraguay) is an error. **New synonymy.**

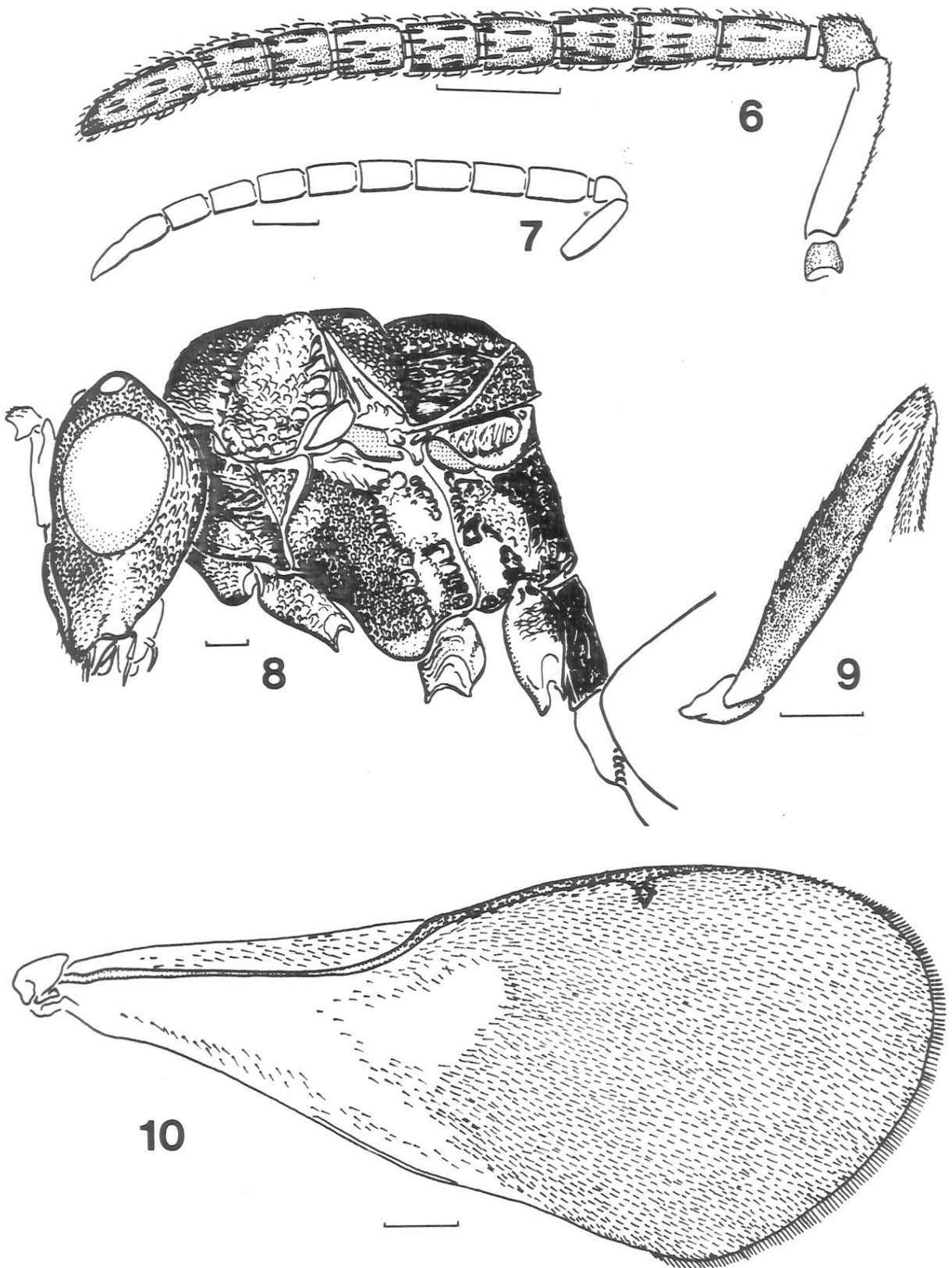
Orasema crassa De Santis, 1968: 3, fig. 1. Type locality: Uruguay, Canelones. Holotype, female [examined, FCNM, type number Za-201], originally designated. **New synonymy.**

Diagnosis.—Within the *xanthopus*-group, both sexes recognized by: frons and mesosomal dorsum finely reticulate; scutellum rounded dorsally (in lateral view) (Fig. 8), axillular sulcus strongly impressed and foveate, at least in basal half; mesepimeron and callus mostly smooth, callus with only few minute setae or bare; petiole smooth with weak and irregular longitudinal rugae; femora of female weakly to strongly fuscate medially (Fig. 9), that of male weakly fuscate or completely yellowish brown

Description of female.—Length, 2.9-3.5 mm. Colour of head and body usually dark (rarely bright) olive or bluish green, sometimes with reddish or stronger bluish reflections.

Head 1.3-1.5X as broad as high (Fig. 5). Face strongly reticulate, intertorular area smooth. Eyes separated by 1.7-1.9X their height. Malar space 0.8-0.9X height of eye. Clypeus and supraclypeal area coriaceous and slightly swollen medially. Flagellum 1.3-1.6X height of head; FL2 1.7-2.2X as long as broad (Fig. 6).

Mesosoma with dorsum finely reticulate, sometimes with overlay of irregular alveolate sculpture on midlobe and/or scutellum. Disc of scutellum slightly longer than broad, rounded dorsally (in lateral view) (Fig. 8), and without median furrow; frenum reticulate; frenal line deeply impressed



Figs. 6-10. *Orasemaxanthopus*. 6, antenna of female. 7, antenna of male. 8, head and mesosoma of female. 9, hind femur of female. 10, fore wing of female. Scale bars represent 0.2 mm.

dorsally, reticulate dorsally and glabrous laterally; axillula vertical and weakly reticulate, striate or smooth; axillular sulcus strongly impressed and foveate, sometimes weakly impressed posteriorly. Propodeal disc reticulate laterally, with or without median longitudinal depression; callus swollen and weakly reticulate, at most with 2-3 minute setae dorsally, callar nib present or absent. Upper mesepimeron swollen and weakly reticulate, lower mesepimeron smooth to areolate. Fore wing 2.2-2.4X as long as broad (Fig. 10).

Petiole 1.5-2.4X as long as broad, 0.7-1.0X as long as hind coxa; petiole smooth with irregular longitudinal rugae, the basal flange prominent or weak. First valvula of ovipositor with lateral line of 7 to 8 prominent teeth; second valvula broad with 9 lateral teeth connected dorsally by weak transverse ridges.

Description of male.—Length, 2.6-3.1 mm. Eyes separated by 1.7-1.9X their height. Malar space 0.7-0.9X height of eye. Flagellum (Fig. 7) slightly longer than in female, 2.0-2.2X height of head. Fore wing 2.0-2.4X as long as broad. Petiole 3.1-3.4X as long as broad, 1.2-1.5X as long as hind coxa.

Distribution (see Fig. 7, Heraty in press-b).—Argentina, Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Uruguay.

Variation.—Minor differences occur in the shape of the body. Specimens from northern Brazil and Ecuador have a generally less robust mesosoma, and the axillula is more distinctly flattened than from southern South America. Fore wings vary in length of the marginal fringe, pilosity of the cubital vein and number of setae surrounding the base of the speculum. Over the range of this species, the anellus may be yellow or brown, but the scape is always a distinct yellow or orangish yellow. The degree of infuscation of the femora of females can vary from only a faint infuscation to an almost complete darkening. Males may have either yellow or infuscate femora, which is typical of other species of *Orasema* in which females have dark femora. The holotype male of *O. paraguayensis* belongs to a dark colored population found in the western Argentinian states of Jujuy, La Rioja and Salta. Individuals of this dark form have the head and mesosoma almost black, and the hind femora of both males and females are dark brown with red-

dish reflections. The variation over the vast range of this species may result from differences in either habitat or host.

Remarks.—Specimens that were referred to as "*Orasema* sp." in papers by Wojcik (1988, 1989, 1990), Wojcik et al. (1987) and Vander Meer et al. (1989) were examined and belong to this species. A single specimen from the Mato Grosso Province in Brazil (Docias [?], iv.1972, ex *Solenopsis* nest, USNM) also belongs to this species, and I assume this is part of the material referred to in Williams and Whitcomb (1973) and Williams (1980). Silveira-Guido et al. (1964) refers to "adults" that were reared from *S. richteri* and identified as *O. doellojuradoi* by Burks (USNM). Silveira-Guido et al. (1964) state that these were subsequently used by De Santis for his description of *O. crassa*. De Santis (1968) makes no reference to the host of this species, nor to Burks' identification, and only the holotype is known from the type locality. Silveira-Guido et al. (1964) refer to other localities in Uruguay (Colonia San Gregorio and Arroceria San Pedro), but I have not been able to examine these specimens. Habitus drawings in Silveira-Guido et al. (1964) appear to be *O. xanthopus* (although with an elongate petiole as in *O. pireta*).

Host Ant.—*Solenopsis invicta* and *Solenopsis* sp. *saevissima*-complex (Myrmicinae) (De Santis 1968; Williams and Whitcomb 1973; Wojcik 1988, 1989, 1990; Wojcik et al. 1987; Vander Meer et al. 1987), and possibly *S. richteri* (Silveira-Guido et al. 1964). The range of *O. xanthopus* is similar to that of the *Solenopsis saevissima*-complex in South America, as illustrated in Wilson (1952). Trager (1991) distinguished 11 species of the *Solenopsis saevissima*-complex that occupy various regions of this same range. The distribution of *O. xanthopus* suggests that it may parasitize more than just the two presently known species.

Host Plant.—Unknown. Males have been collected resting on grasses and a variety of broad-leaf plants over fire ant nests [a variety of grasses, annuals, herbs, legumes, shrubs, and trees were examined for evidence of egg laying and planidia without success].

Habitat.—Disturbed Cerrado, pantanal, and Campo Limpo. Most of the fire ant colonies collected in the 1984-86 survey were found along road

shoulders where fire ants flourish. The soils along the roads varied considerably. Fire ant colonies were generally collected in disturbed habitats.

Immature stages.

Eggs (dissected from abdomen).—Stalked eggs as typical of other *Oreasema*.

First-instar larva (Figs. 11-13, 15, 16).—Larval form typical for *Oreasema* and recognized by the following features: three pairs of cranial sensillae, cranial spines absent; terga IV-VI acuminate laterally, terga VII-VIII strongly scalloped ventrally; caudal cerci short; desclerotized lines from base of setae prominent. Average length of unfed larva 0.21 mm (SD= 0.02, n = 5), maximum size of distended first instar (Fig. 16) 1.20 mm (n=1).

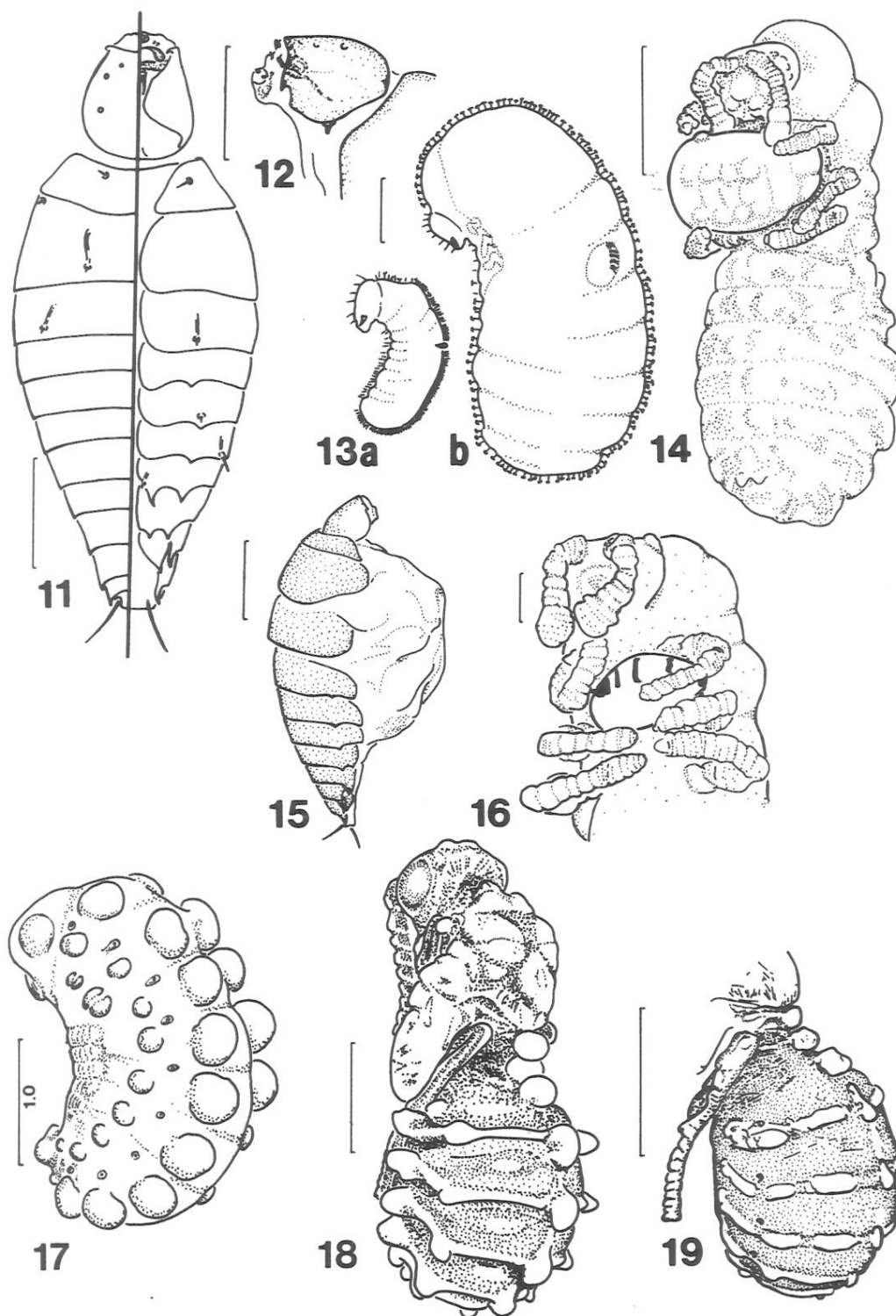
Second-instar larva (Fig. 14).—Recognized by the following characters: body white and unsclerotized; mandibles lacking; only a single mesothoracic spiracle anteroventral of first tubercle; only nine dorsal tubercles present, tubercles slightly raised. Length 1.26 mm (n=1).

Third-instar larva (Fig. 17).—Mature larvae recognized by: body white and poorly sclerotized, dorsal surface smooth; oral region with circular region of fine striae convergent to midline, mandibles lacking; two thoracic and seven abdominal spiracles present on raised tubercles on body segments II-X; body segments II-X with nine enlarged dorsolateral tubercles, segments I-X with series of ten smaller lateral tubercles; segments II and III with pair of medially divided tubercles lateral to oral region. Average length of pupa 2.81 mm (SD=0.13, n=10). Prepupa recognized by definition of antennal segments on ventrolateral margins of abdominal segments and by tubercles more prominent.

Pupa (Fig. 8).—Pupal form is typical for other species of *Oreasema* and is recognized by: three enlarged tubercles over petiole; five transverse abdominal ridges with prominent tubercles dorsally (much larger than for other species), laterally and subventrally. Average length 3.43 mm (SD=0.21, n=10).

Material Examined.—[in following list, ?=adult with sex undetermined; L=larvae; P=pupae; PH=phthisergate] ARGENTINA: *Jujuy*: Palpala, i (1?, NMBA); *La Rioja*: February (1 female, NMBA); *Salta*: (1 male, NMBA); Cachi, i (1 fe-

male, MLTA); *Santiago del Estero*: i (1 female, MCZ). BOLIVIA: *Santa Cruz*: San Matias, iii, ex floated *S. invicta* [colony] 86-131 (6P); 5 km E of San Matias, iii, ex floated *S. invicta* 86-136 (1L, 9P) & 86-137 (3?, 1L, 9P); Las Juntas, xii (2 females, CARN). BRAZIL: *Amazonas*: Manaus (1 female, USNM); Fonte Boa, ix (14 females, CNC); *Goias*: Jatai, xi (1 female, CNC); *Mato Grosso*: Cáceres, ex *S. invicta* 86-49 & 86-102 (5 females, 2 males, 6L, 9P, JMH); Cáceres, viii, ex *S. invicta* 85-450 (15 females, 31P, JMH); Cáceres, viii, 85-388, ex *S. invicta* (15 females, 4 males, 6P, JMH, NMBA); Docias[?], iv, *Solenopsis* nest (1 female, USNM); Fazenda Paiól, BR-070, km 677, 50 km E of Cáceres, vii, ex floated *S. invicta* 85-388 (13?, 3L, 35P, 7PH, FLA); Fazenda Sta. Isabel, Reserve do IBDF, MT-060, km 118 (Transpantaneira), xii, ex floated *S. invicta* 84-306 (4?, 6P, FLA); Fazenda SATO, BR-070, km 708, 19 km E of Cáceres, xi, ex floated *S. invicta* 86-570 (7?, 23L, 135P, 1PH, FLA); Fazenda SATO, BR-070, km 708, 19 km E of Cáceres, xi, ex floated *S. invicta* 86-571 (2?, 33L, 157P, 1PH skin with large larva attached, JMH); Porto Jofre, xii, ex floated *S. invicta* 84-296 (1?, FLA); Quatro Marcos, Fazenda Bela Vista, iv, ex floated *S. invicta* 85-B-164 (3?, 3L, 20P, 1PH, FLA); Sete porcos, BR-070, km 616, (100 km W of Cuiabá), viii, ex floated *S. invicta* 86-B-451 (2?, 1L, 8P, FLA); Jacobina, BR-070, km 701, 26 km E of Cáceres, viii, ex floated *S. invicta* 85-421 (5?, 17P, FLA); Jacobina, BR-070, km 701, Jacobina, 26 km E of Cáceres, viii, ex floated *S. invicta* 85-422 (5?, 13P, FLA); *Mato Grosso do Sul*: Corumba (1 female, USNM); MS-80, 48 km NW of Campo Grande, ii, ex floated *S. invicta* 86-B-49 (19?, 67L, 412P, 46PH, JMH) & also 2 males flying over same colony; same locality, iii, 86-B-64 (23?, 5L, 312P, 13PH, JMH); same locality, iii, 86-B-65 (59?, 53L, 444P, 21PH, FLA, NMBA) & 10 flying over same colony; same locality, vi, 86-320 (4?, 7L, 19P, 1PH skin, FLA); Rochedo, iii, ex floated *S. invicta* 86-B-102 (2P, FLA); Jacobina, BR-70, km 32, viii, 85-422 & 85-421, ex *S. invicta* (4 females, 5 males, JMH); *Para*: Belm, vii (1 male, USNM); Jacareacanga, xii (5 females, AEI); Santarem (1 female, CARN); Santarem (3 females, USNM). COLOMBIA: *Amazonas*: Leticia, ii, MT (4 females, CNC). EC-UADOR: *Napo*: Cocoa River, iv (2 females, CNC);



Figs. 11-19. 11-18. Immature stages of *Orasema xanthopus*. 11, unfed first-instar, dorsal (left) and ventral (right) view. 12, head of unfed first instar in lateral view. 13, first instar larva: a, external position of first instar (arrow) on second-instar larva of *Solenopsis invicta*; b, partially fed first instar beneath cuticle of fourth-instar larva of *Solenopsis*. 14, second instar feeding on host pupa. 15, partially fed first instar removed from host larva. 16, first instar feeding in external position on host pupa. 17, mature third instar in lateral view. 18, pupa in dorsolateral view. 19, *O. salebrosa*, metasoma of female pupa. Scale bars represent mm in following scales: 11, 12 = 0.04; 13, 16 = 0.5; 15 = 0.05; 14, 17-19 = 1.0.

Tena, ii (5 females, CNC); Tena, ii (2 females, CNC); Tena, ii (2 females, CNC); Puerto Misahuali, 350m, ii (1 female, CNC); Limoncocha, ii (4 females, CNC); Limoncocha on Rio Napo, i-iii MT (8 females, FLA). GUYANA: Georgetown, vi (1 female, UMS). PERU: Loreto: Dept. Loreto Explorama Inn, 40 km NE Inquitos on Amazon R., vii (1 female, CNC); Madre de Dios: Avispas, 400m, ix, (4 females, CNC). URUGUAY: Artigas, iii, fire ant project (2 females, USNM).

Behaviour of O. xanthopus.—Observations on *O. xanthopus* parasitizing *S. invicta* were made as part of a survey to evaluate the natural biological control agents of fire ants in Mato Grosso (MT) and Mato Grosso do Sul (MS), Brazil. The survey was conducted by flotation examination of standardized fire ant nest samples of 2-1/2 liters of tumulus (Wojcik 1988). From June 1984 through December 1986, 1585 fire ant colonies were sampled. Most colonies were collected within 150 km of Cáceres (MT); some samples were collected near Cuiabá and along the Transpantaneira highway from Poconé to Porto Jofre (MT), 228 colonies from within 200 km of Campo Grande (MS), and 16 colonies from western Bolivia.

Orasema xanthopus occurred in 33.2% of the collections from *Solenopsis* nests made in the Central-West region of Brazil, and was the most commonly collected myrmecophile in *S. invicta* (=saevissima-complex) nests (Wojcik 1988). The average number of parasites collected was 18.3 per nest, although one colony contained 598 *O. xanthopus* larvae, pupae, and adults. Larval counts do not include first-instar larvae and parasitism rates are higher than was first recorded. Monthly collection data show a consistent presence of all life stages with *O. xanthopus* present in 18.5-67.5% of colonies examined throughout the year (Table 1).

Aspects of biology for this species, studied in laboratory fire ant nests, are similar to other *Orasema* species (Wheeler 1907, Johnson et al. 1986). The particular plants utilized by this species for oviposition were not determined. First-instar larvae were found on the external surface of second-instar ant larvae or just under the cuticle of mature ant larvae (Figs. 8, 9), entering the host at various locations on the dorsal region of the thorax and abdomen. Only one endoparasitic first-instar larva was observed

per host larva or pupa. Partial endoparasitic feeding, as evidenced by distention of the first-instar larva (Fig. 11), took place only after the parasite burrowed into the host (Fig. 9). After host pupation, the now ectoparasitic first and later instars feed on the ventral region of the thorax, between the deformed pupal legs of the host (Fig. 12). Mature larvae detach themselves from the host after feeding is completed. The host may or may not be entirely consumed, we have 3 examples of large *O. xanthopus* larvae with their heads (mouthparts) still inserted in the cuticular skins of completely or mostly consumed ant pupae. Deformed host pupae, resulting from incomplete feeding, remain alive within the nest and are here referred to only as phthisergates (after Wheeler 1907). Phthisergates may live for some time in the colonies, but never develop into adult ants. Their presence is diagnostic of parasitism by *Orasema*.

During the pupal period, parasite pupae are mixed in with host brood, and are cared for like ant pupae (Silveira Guido et al. 1964, Williams 1980, Wojcik 1990). Worker ants assist eclosion by the parasite pupae in the same manner as the ants assist their own pupae (Silveira Guido et al. 1964, Wojcik 1990). Fed and groomed by the worker ants, adult parasites are temporarily integrated into the colony (Silveira Guido et al. 1964, Williams 1980, Wojcik 1990). When a nest is disturbed, the pupal and adult parasites are rescued by the ants seemingly in preference to their own brood (Wojcik 1990). Several ants in the alcohol samples were found clutching the dorsal nodes of larvae and pupae.

The manner in which adults of *O. xanthopus* leave the nest has not been observed. Males hover over the ant nest, or rest on grasses and other plants around and over the fire ant nests (Williams 1980, Wojcik & Jouvenaz unpublished). Mating swarms, with males flying in a low swarm over the fire ant mound, were observed over a three-day period at one site in Mato Grosso do Sul (MS-80) in March, 1986. Case 1: colony 86-B-49, 4 days after being disturbed by digging; flight activity was high when observations started at 8:45 AM, with activity subsiding by 9:15 A.M., but continuing until 9:34 A.M. with an increase in winds and temperature, none of the other 15 other mounds within 100 m showed any flight activity of *Orasema*. Case 2: colonies 86-

Table 1. Summary of collections of *Orasema xanthopus* floated from South American fire ant colonies, June 1984 to December 1986. Counts do not include first-instar larvae.

Month	Colonies examined	Colonies w/ <i>Orasema</i>	%	# of larvae	Colonies w/larvae	# of pupae	Colonies w/pupae	# of adults	Colonies w/adults	Total <i>Orasema</i>	Mean	Range
Jan	86	30	34.9	146	14	230	28	48	21	424	14.1	1-123
Feb	115	65	56.6	305	26	1451	62	230	34	1985	30.5	1-598
March	106	33	31.1	107	20	894	24	97	11	1098	33.3	1-556
April	40	27	67.5	86	15	304	27	43	10	433	16.0	1-165
May	189	51	27.0	85	15	456	46	109	29	650	12.8	1-154
June	164	41	25.0	367	19	845	36	84	13	1296	31.6	1-446
July	132	54	40.9	93	12	416	46	171	39	680	12.6	1-74
Aug	225	79	35.1	85	24	924	70	255	46	1264	16.0	1-203
Sept	142	42	29.6	15	4	222	35	84	20	321	7.6	1-59
Oct	146	27	18.5	23	13	160	22	25	12	208	7.7	1-60
Nov	171	62	36.3	215	25	874	55	75	24	1164	18.8	1-192
Dec	69	15	21.7	6	4	63	12	31	11	100	6.7	1-29
Totals	1585	526	33.2	1533	191	6839	463	1252	270	9623	18.3	1-598

B-64 & 86-B-65, 3 days after being disturbed by digging, 86-B-65 moved 1 m NW; flight activity was observed at 11 AM after sun appeared from clouds (heavy overcast until then); winds calm. Case 3: colonies 86-B-64 & 86-B-65, 4 days after being disturbed by digging; flight activity was high when observations started at 9:11 AM, light overcast till 10:25 then full sun, sporadic flying with full sun for 1/2 hr before wasps ceased to fly, one of the other 6 mounds within 100 m had flight activity; winds calm. Wojcik observed several males that approached and attempted to mount other resting males on grass leaves or stems over the ant mound at the edges of the swarm. The standing males repelled the apparently misguided males by wing flipping, by antennal fencing, or by leaving the area.

Mating takes place immediately after adult parasites leave the nest (Williams 1980). Based on the relatively even distribution of the larvae, pupae, and adults collected (Table 1), it seems likely that overlapping multiple generations occur in Central-West Brazil and mating takes place whenever weather conditions are suitable. No fire ant mating flights occurred during the wasp mating swarms (from any colonies within walking distance) and no unusual fire ant activity was observed on any of the studied mounds.

Studies of cuticular hydrocarbons have shown that *O. xanthopus* larvae, pupae and adults possess only host *Solenopsis* sp. cuticular hydrocarbons while in the ant nest. After leaving the host nest, adult *O. xanthopus* acquire species-specific cuticular hydrocarbons and lose the majority of the host *Solenopsis* sp. cuticular hydrocarbons (Vander Meer et al. 1989).

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